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Appendix D - Hydrology Studies

Appendix D – Hydrology Modeling

Hydrology Model Assumptions With Some Comparisons to Actual Operations

- For consistency in all model runs the reservoirs were assumed to be at the same level entering year 0. Average October 1 reservoir elevations used are Anderson Ranch Reservoir – 285,500 acre-feet, Arrowrock Reservoir 114,000 acre-feet, and Lucky Peak Lake – 104,000 acre-feet.

- Flood control goals, irrigation demands, and minimum streamflow targets are met where water supply and runoff allow within the maximum pool limitations required for construction.

- Drawdown of Lucky Peak for construction is set to begin on the same date for each year of construction and each water supply scenario (wet, average, dry). In actual operations, drawdown would depend on water supply and year of construction. In wet years, drawdown would begin as early as mid -July as soon as flood control operations allow since the higher inflows would reduce the volume the reservoir could be drafted per day. Irrigation demand would probably start the draft in a dry year sometime around the end of July or early August. Draft in an average water year could potentially be later than for a wet or dry year. The required drawdown of Arrowrock Reservoir would likely be met through irrigation deliveries but may require some spilling in a wet year.

- Drawdown rate of Lucky Peak Lake is limited by a maximum flow of 5,000 cfs at Glenwood Bridge during the irrigation season. This restriction is intended to prevent washout of the greenbelt and to reduce subsurface inundation of fields near the river.

- Boise River Basin releases for salmon flow augmentation are assumed in the model to be 400 cfs in a wet or average year and 100 cfs in a dry year. In the model, these releases would be made between July 1 and August 31 regardless of the water condition. In actual operations, flow augmentation would start on a different day for each type of water year and possibly for each alternative. Also, flow rates would vary from year-to-year depending on the amount of water that accrues to assigned space, powerhead, and water bank purchases up to the full amount of 40,000 acre-feet for salmon flow augmentation.

- The model uses a “perfect forecast” for determining the desired end of month target reservoir contents for flood control and refill. The model uses historic runoff from the beginning of a month to the end of the flood season to compute which of seven rule curves (ranging from very wet to very dry) to use as a target for end of month contents. In real time operations, forecasts are based on actual conditions to date then assume normal precipitation from that date to July 31. This can result in overdrafting if the remainder of the water year is very dry or high flood control releases if precipitation during the rest of the year is far above average.

- The model has a flood control rule curve for each reservoir and when water surface elevations reach a certain point, water is released from that reservoir. In actual operations, there is a combined system space requirement. Reclamation attempts to keep a certain percent of flood control space in the lower reservoirs depending on the time of year, but the major concern is the overall system space, not the space in a particular reservoir.

- The model uses flood control rule curves that are absolute (cannot be violated) and won't allow the reservoir elevation to rise above the rule curve elevation forcing releases from the system and causing some spikes in flows. In actual operations, operators try to keep the releases more consistent and would allow the reservoirs to go above rule curves or into surcharge for short periods of time to reduce spill and flooding downstream.

- For the model, reservoir elevations and diversion demands are set and releases fluctuate to meet those constraints. In actual operations, the releases are set and the demands and reservoir elevations fluctuate slightly to meet the release constraint.

- In actual operations, Lucky Peak Lake is kept full to the extent possible through Labor Day in average and wet water years by drafting Arrowrock and Anderson Ranch Reservoirs. After Labor Day, Arrowrock is shut off and irrigation demand for the rest of the season is supplied by drafting from Lucky Peak Lake.

- Two irrigation diversion patterns were used–one for full water supply years and one for less than full water supply--to allow for changes in irrigation practices that occur during dry years. In actual operations, irrigation diversions change from year to year.

- The model includes a target minimum pool elevation for Lucky Peak Lake during the third construction period to address potential loss of bull trout. The target selected for the model is 2959 feet; however, a target of 2957 has since been requested and would probably be used in actual operations. A significant portion of the upstream adult migratory bull trout population may move (be entrained through Arrowrock Dam) into Lucky Peak Lake when Arrowrock Reservoir is drafted for maintenance or construction. A sufficiently large pool in Lucky Peak Lake would help maintain habitat for bull trout and other aquatic life in Lucky Peak and reduce possible entrainment of bull trout through Lucky Peak Dam and loss to downstream reaches. The bull trout would be maintained trapped, hauled back to Arrowrock Reservoir, and released after the lower outlets are closed at the end of construction.

- The model assumes that water deliveries would not be made to the New York Canal from October 15 through December 31. This is similar to actual operations. The Boise Project Board of Control (BPBOC) typically closes the New York Canal from the end of the irrigation season until December 31 for maintenance purposes, and after January 1, diverts water down the New York Canal to start filling Lake Lowell. Water that is "spilled" from Lucky Peak prior to or during construction in excess of winter minimum flows would be available to the New York Canal. If BPBOC decides to divert these excess flows between October 15 and December 31, riverflows at Glenwood Bridge would be lower than indicated on the hydrographs.

ARROWROCK RESERVOIR END OF MONTH RESERVOIR ELEVATION - FEET

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1970	3097.34R	3133.32R	3165.07R	3208.00R	3213.15R	3213.25R	3213.90R	3211.52R	3216.02R	3187.07R	3067.82R	3084.10R
1971	3130.04R	3166.90R	3209.80R	3213.36R	3213.25R	3182.30R	3200.39R	3211.28R	3216.80R	3204.35R	3113.17R	3109.10R
1972	3153.05R	3190.41R	3112.33R	3212.64R	3183.04R	3193.70R	3158.15R	3197.00R	3216.20R	3180.34R	3063.37R	3085.22R
1973	3125.62R	3163.43R	3211.44R	3212.45R	3213.13R	3213.43R	3214.72R	3204.04R	3177.37R	3076.36R	3024.47R	3063.02R
1974	3107.96R	3135.76R	3174.19R	3213.39R	3209.24R	3202.58R	3200.24R	3203.54R	3211.44R	3193.00R	3114.91R	3105.95R
1975	3138.06R	3142.40R	3190.62R	3213.31R	3213.70R	3212.80R	3130.68R	3111.76R	3167.10R	3181.73R	3125.27R	3099.80R
1976	3136.00R	3169.34R	3208.50R	3213.33R	3211.68R	3206.40R	3183.10R	3197.20R	3206.20R	3162.70R	3067.84R	3061.06R
1977	3113.73R	3139.00R	3160.00R	3183.30R	3185.00R	3126.20R	3060.30R	3044.80R	3038.90R	3058.80R	3049.80R	2994.00R
1978	3087.80R	3119.67R	3161.46R	3165.00R	3170.29R	3213.12R	3176.00R	3141.80R	3176.11R	3165.27R	3071.80R	3104.79R
1979	3133.94R	3155.09R	3174.96R	3195.13R	3213.11R	3213.73R	3208.30R	3192.92R	3208.30R	3087.36R	3081.00R	3093.16R
1980	3120.56R	3144.60R	3166.33R	3191.65R	3213.80R	3213.57R	3215.33R	3215.00R	3215.83R	3187.69R	3123.37R	3166.22R
1981	3092.36O	3130.89O	3161.00O	3190.56O	3214.21O	3215.93O	3216.00O	3216.35O	3207.40O	3139.70O	3085.18O	3088.18O
1982	3107.72	3144.86	3181.03	3196.46	3190.40	3156.80	3150.89	3208.88	3217.36	3206.32	3143.61	3153.46
1983	3181.78O	3135.65O	3146.91O	3131.26O	3128.41O	3152.37O	3158.79O	3206.01O	3215.34O	3195.62O	3103.37O	3094.85
1984	3122.84H	3196.29H	3183.62H	3114.82H	3118.20H	3153.79H	3183.24H	3200.21H	3216.71H	3191.44H	3112.76H	3174.45H
1985	3158.52V	3153.54V	3155.19V	3167.23V	3188.60V	3195.03V	3202.71V	3205.73V	3200.26V	3148.15V	3085.51V	3109.91V
1986	3148.40V	3174.99V	3180.24V	3202.78V	3216.05V	3192.52V	3182.78V	3196.94V	3214.86V	3162.50V	3185.06V	3168.50V
1987	3179.37V	3169.98V	3181.55V	3199.72V	3197.46V	3176.69V	3152.42V	3146.93V	3116.75V	3082.25V	3057.46V	2967.00V
1988	3081.35V	3116.06V	3143.88V	3060.14V	3165.05V	3181.76V	3144.71V	3113.56V	3058.21V	3027.73V	3006.02V	2999.00V
1989	3077.71O	3115.00V	3138.08V	3156.68V	3170.47V	3184.02V	3188.25V	3178.73V	3157.16V	3071.15V	3025.40V	3033.40V
1990	3067.95V	3104.50V	3123.82V	3141.16V	3155.88V	3172.73V	3132.58V	3123.94V	3154.32V	3096.80V	3081.60V	3091.30V
1991	3123.98V	3148.36V	3167.38V	3186.21V	3198.87V	3187.07V	3084.04V	3071.11V	3080.69V	3055.97V	3055.70V	3025.16O
1992	3089.07V	3122.20V	3135.97V	3147.60V	3160.40V	3160.06V	3126.86V	3063.14V	3057.65V	3040.57V	3066.59V	3081.66V
1993	3103.16V	3121.52V	3136.69V	3151.64V	3160.42V	3190.34V	3206.24V	3212.92V	3213.23V	3179.36V	3110.46V	3125.45V
1994	3160.48O	3174.03V	3188.00O	3198.65O	3194.19O	3186.79V	3156.59O	3119.99V	3084.48O	3081.08V	3045.00O	3047.87V
1995	3078.43V	3104.87V	3128.57O	3156.67V	3192.76V	3198.97V	3201.12V	3190.64V	3215.97V	3201.94V	3134.29V	3092.46V
1996	3136.29V	3169.54V	3182.54V	3196.37V	3185.12V	3149.92V	3183.92V	3202.84V	3215.27V	3197.64V	3104.00V	3098.98O
1997	3135.04V	3171.94O	3204.63O	3186.85O	3133.14O	3110.48O	3137.98O	3193.76O	3212.08O	3197.24O	3107.64O	3093.38O
1998	3124.88V	3156.36O	3176.67O	3195.29O	3193.86V	3212.24O	3213.18O	3216.36O	3216.30O	3192.49O	3114.94O	3120.83O
1999	3130.87O	3153.76O	3174.45O	3198.22O	3196.77O	3147.33O	3144.43O	3184.21O	3215.52O	3185.47O	3102.61O	3115.17O
2000	3114.51O	3138.04O	3157.27V	3178.81O	3199.53O	3206.17O	3211.95V	3212.46O	3207.29O	3163.98O	3092.96O	3101.82V
AVERAGE	3121.25	3147.17	3167.17	3179.96	3187.07	3184.58	3172.25	3174.05	3178.29	3145.23	3087.84	3088.69
MAXIMUM	3181.78	3196.29	3211.44	3213.39	3216.05	3215.93	3216.00	3216.36	3217.36	3206.32	3185.06	3174.45
MINIMUM	3067.95	3104.50	3112.33	3060.14	3118.20	3110.48	3060.30	3044.80	3038.90	3027.73	3006.02	2967.00

H - Hydromet system
O - Project office
R - Annual Water Supply Report
V - Loaded directly from ARCHIVES

LUCKY PEAK LAKE END OF MONTH RESERVOIR ELEVATION - FEET

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1964	2928.58G	2929.12G	2931.60G	2973.24G	2971.17G	2997.02G	3022.38G	3040.65G	3058.61G	3055.15G	3051.28G	2984.83G
1965	2952.15G	2955.84G	2979.17G	2994.42G	2925.50G	2919.49G	2926.00G	2980.16G	3053.33G	3055.08G	3055.02G	3000.41G
1966	2958.20G	2958.15G	2976.73G	3017.52G	3043.38G	3051.54G	3042.66G	3055.51G	3055.40G	3052.58G	2999.92G	2922.98G
1967	2906.03G	2943.14G	2946.14G	2950.35G	2936.84G	2942.21G	2942.62G	2968.76G	3055.62G	3055.47G	3027.26G	2964.58G
1968	2930.88G	2934.95G	2933.97G	2935.36G	2971.32G	3012.76G	3045.04G	3053.95G	3055.55G	3020.88G	2988.04G	2917.25G
1969	2919.09G	2924.46G	2927.42G	2955.48G	2945.75G	2931.38G	2946.40G	3042.45G	3055.17G	3055.05G	3043.18G	2984.45G
1970	2956.38G	2955.43G	2955.56G	2969.93G	2965.45G	2986.92G	2975.95G	2997.52G	3058.07G	3055.45G	3054.39G	3012.43G
1971	2981.13G	2984.32G	2983.12G	3008.47G	2961.20G	2942.47G	2936.62G	3016.54G	3057.82G	3055.46G	3055.41G	3092.18G
1972	2953.71G	2956.03G	2976.44G	2992.61G	2956.98G	2945.33G	2953.12G	2977.89G	3049.08G	3055.61G	3053.43G	3003.65G
1973	2979.17G	2977.18G	2940.76G	2996.64G	3020.49G	3041.08G	3048.26G	3054.26G	3055.17G	3055.54G	3007.71G	2952.92G
1974	2935.40G	2958.33G	2947.70G	2972.15G	2964.49G	2971.45G	2978.85G	2994.83G	3052.64G	3055.09G	3055.25G	2992.23G
1975	2943.41G	2955.35G	2951.08G	2951.40G	2982.79G	2987.37G	2972.14G	2981.54G	3054.20G	3055.17G	3055.05G	3012.40G
1976	2949.09G	2943.40G	2941.62G	2959.99G	2962.74G	2973.22G	3017.45G	3046.39G	3055.35G	3055.14G	3054.60G	3008.11G
1977	2968.80G	2962.60G	2955.78G	2953.65G	2975.03G	3047.23G	3053.09G	3039.00G	3022.65G	2978.25G	2932.09G	2921.82G
1978	2918.46G	2917.02G	2929.42G	2956.76G	2963.78G	2980.54G	3002.37G	3033.63G	3055.41G	3054.93G	3054.80G	2999.15G
1979	2967.76G	2965.39G	2963.56G	2961.72G	2972.18G	3017.04G	3035.88G	3055.32G	3055.29G	3053.79G	3015.87G	2930.49G
1980	2933.20G	2931.59G	2931.20G	2936.82G	2949.34G	2977.44G	3033.57G	3048.69G	3055.77G	3055.25G	3054.71G	2988.93G
1981	2940.36G	3038.98G	3039.68G	3039.46G	3042.75G	3046.76G	3051.45G	3056.61G	3054.99G	3054.68G	3018.13G	2939.38G
1982	2921.06G	2920.16G	2926.29G	2955.20G	2990.93G	2980.54G	2951.12G	2947.04G	3057.18G	3055.31G	3054.69G	3001.12G
1983	2958.54G	3031.82G	3034.92G	3027.18G	3016.75G	3037.74G	3020.93G	3023.78G	3054.04G	3055.27G	3054.84G	2998.79G
1984	2959.71H	2961.22H	3014.30H	3020.29H	3014.14H	3019.91H	3032.49H	3014.70H	3056.27H	3055.43H	3055.16H	2936.55H
1985	2929.88H	2932.01H	2932.45H	2930.38H	2930.12H	2978.09H	3035.25H	3054.19H	3055.31H	3055.04H	3036.99V	2977.49V
1986	2927.38V	2925.92V	2921.80V	2914.26V	2993.62V	3024.72V	3031.10V	3035.47V	3054.97V	3055.68V	2960.07V	2942.44V
1987	2941.11V	2941.29V	2935.61V	2933.45V	2952.53V	3025.76V	3055.29V	3055.23V	3054.59V	3032.60V	3002.10V	2961.41V
1988	2951.68V	2948.74V	2946.34V	2952.26V	2974.88V	2979.01V	3041.56V	3055.44V	3050.06V	3021.53V	2953.48V	2915.39V
1989	2921.25V	2925.86V	2929.69V	2938.21V	2944.56V	2997.48V	3034.72V	3050.92V	3054.67V	3054.62V	3014.49V	2948.34V
1990	2941.78V	2947.83V	2956.85V	2965.62V	2971.71V	2986.81V	3045.80V	3055.21V	3054.78V	3054.83V	3019.65V	2968.14V
1991	2952.31V	2948.35V	2944.20V	2941.21V	2938.65V	2961.99V	3042.39V	3054.51V	3051.93V	3024.70V	2958.93V	2909.19V
1992	2905.79V	2916.14V	2936.14V	2949.91V	2967.08V	3008.49V	3040.77V	3046.96V	3003.43V	2949.26V	2915.24V	2916.46V
1993	2923.73V	2926.75V	2927.38V	2931.41V	2947.16V	2999.59V	3037.12V	3044.07V	3054.82V	3054.93V	3054.59V	3000.60V
1994	2968.49O	2968.33V	2967.68O	2957.90O	2971.13O	2985.87V	3018.68O	3054.47V	3051.42O	2997.28V	2949.71O	2925.75V
1995	2932.33V	2937.43V	2943.39V	2940.34V	2951.78V	3012.77V	3033.32V	3035.96V	3054.91V	3054.66V	3054.45V	3021.22V
1996	2989.67V	2986.57V	2986.32O	2971.14V	2975.73V	2979.47V	2994.89V	3026.66V	3051.47V	3054.84V	3053.02V	3002.11O
1997	2973.59V	2972.95O	2975.08O	2988.03O	2996.78O	2983.82O	2966.44O	2999.41O	3053.11O	3054.64O	3054.28O	3004.90O
1998	2973.69V	2972.75O	2972.02O	2979.68O	2998.14V	3014.01O	3036.96O	3052.70O	3054.45O	3054.90O	3053.75O	2990.35O
1999	2966.84O	2969.66O	2973.46O	2974.80O	2980.43O	2996.53O	2992.99O	3038.31V	3052.19O	3055.06O	3054.29O	2978.82O
2000	2958.24O	2962.35O	2967.03V	2967.71O	2980.85O	3022.68O	3042.61V	3054.85O	3055.20O	3054.99O	3042.41O	2968.97V
AVERAGE	2945.18	2952.90	2955.19	2965.06	2972.85	2993.42	3013.21	3032.62	3052.50	3044.97	3022.66	2970.30
MAXIMUM	2989.67	3038.98	3039.68	3039.46	3043.38	3051.54	3055.29	3056.61	3058.61	3055.68	3055.41	3092.18
MINIMUM	2905.79	2916.14	2908.51	2914.26	2925.50	2919.49	2926.00	2947.04	3003.43	2949.26	2915.24	2905.30

G - Published by USGS, O - Project office
H - Hydromet system, V - Loaded directly for ARCHIVES